REMARKS

The abstract has been amended to better comply with the requirements of MPEP 608.01(b), and the specification has been amended to correct some minor grammatical errors of which the undersigned has become aware.

In addition, the claims have been amended to make minor grammatical improvements and to correct minor antecedent basis problems so as to put the claims in better U.S. form. These amendments are clearly not related to patentability and do not narrow the scope of the claims either literally or under the doctrine of equivalents.

Submitted herewith are marked copies of the changed pages of the abstract, specification and claims to show that no new matter has been added.

It is respectfully requested that the amendments to the abstract, specification, and claims be approved and entered, and that prosecution on the merits proceed in light of this Preliminary Amendment.

Respectfully submitted,

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ELECTROMAGNETIC DRIVE

This application claims the benefit of Japanese Application No. 2001-294421, filed in Japan on September 26, 2001, the entire contents of which are incorporated herein by ~~this~~ reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a construction of an electromagnetic drive for controlling the amount of light of a luminous flux.

2. Description of the Related Art

Hitherto, an electromagnetic unit, which is an electromagnetic drive, is employed in a light amount controlling unit such as a light exposure controlling unit for controlling the light exposure of a camera or the like as a driving source. For example, a light amount controlling unit for a conventional lens barrel shown in a cross section in Fig. 19 employs an electromagnetic unit shown in a cross section in Fig. 20 as a drive source.

The conventional lens barrel 110 includes a taking lens 112 held by a lens frame 111, and an opening 111a is provided on the lens frame 111 at the position behind the taking lens. Two shutter blades 113, 114 are rotatably supported by supporting pins 117b, 117a around the opening

111a. The shutter blades 113, 114 are rotated by the electromagnetic unit 100 via a drive pin 115a of a shutter lever 115 to open and close the opening 111a.

The electromagnet unit 100 is a plunger type electromagnet unit, and comprises a solenoid including a yoke 103 and a bobbin 102 supported by the yoke 103 and having a coil 101 wound thereon, and a plunger 105 being a movable iron core to be inserted into a hollow space potion of the bobbin 102, as shown in a cross sectional view of Fig. 20. The plunger 105 is urged by a coil spring 106 toward the direction of projection, and is sucked when the coil 101 is energized by a power source 107.

An end of the shutter lever 115 rotatably supported by the lens frame 111 abuts against the distal end of the plunger 105. When the coil is not energized, the plunger 105 is projected and the shutter blades 113, 114 are rotated to the close position by the shutter lever 115. When the coil is energized, the plunger 105 is sucked and thus the shutter lever 115 rotates clockwise by a torque of a torsion spring 116, and the shutter blades 113, 114 are rotated into the open position.

light exposure controlling unit
The ~~one~~ disclosed in Japanese Unexamined Patent Application Publication No. 4-194912 also employs a plunger-type electromagnetic drive having the same construction as the electromagnet unit 100 applied to the conventional light

The present invention is intended to solve the disadvantage described above, and ~~an object of the present invention is to~~ provides an electromagnetic drive which is integrated in an optical apparatus for controlling the amount light of a luminous flux and which is ~~being~~ capable of efficient use of the space where it is placed.

One of the electromagnetic drives of the invention is a unit for controlling the amount of light of a luminous flux comprising a solenoid in which a winding axis of the coil lies in parallel with the direction of the luminous flux, a movable iron core to be moved by a magnetic force of the solenoid in the direction parallel with the direction of the luminous flux, and a blade member to be driven by the movable iron core for controlling the amount of light.

Another one of the electromagnetic drives of the invention is a unit for controlling the amount of light of a luminous flux comprising a plurality of solenoids in which the winding axes of the coils lie in the direction perpendicular to the direction of the luminous flux, a movable iron core to be moved by a magnetic force of the solenoid in the direction perpendicular to the direction of a luminous flux, and a blade member to be driven by the movable iron core for controlling the amount of light of a luminous flux.

Other characteristics and benefits of the invention

shutter blades 4, 5 are rotated about the supporting pins 3c, 3e via the driving holes 4b, 5b, and are movable from the closed position shown in Fig. 2 to the opened position shown in Fig. 3.

The shutter blade opening/closing mechanism comprises an electromagnetic unit 11, a shutter lever 7 as a switching means for switching the direction in which a locomotive faculty of the plunger (iron core) 17 acts, which will be described later, and a shutter opening spring 8.

The shutter lever 7 comprises a shaft hole 7a, a plunger abutment portion 7b, a shutter driving pin 7c, and a spring hook 7d. The shaft hole 7a is rotatably fitted on the supporting shaft 3b on the shutter body 3, and the shutter driving pin 7c is fitted through the pin insertion hole 3c of the shutter body 3 and then fitted into the driving holes 4b, 5b of the shutter blades.

The electromagnetic unit 11 is ~~a~~ an electromagnet of a plunger type, and comprises, as shown in ~~a~~ the cross sectional view of Fig. 6, two plate-shaped yokes including a mounting yoke (first yoke member) 12 and a yoke on the side of the projecting end of the plunger (first yoke member) 13 formed of magnetic material, a fixed iron core (second yoke member) 19 formed of magnetic material and held between the yokes 12 and 13 to be inserted into the axial center of the coil (solenoid) 16 that will be described later, a fixed iron

core 18 formed of magnetic material and serving ~~serves~~ as a plunger stopper to be fixed on the side of the yoke 12, a bobbin 15′ to be fitted on the outer periphery of the fixed iron core 19 and held between the yokes 12 and 13, a bobbin 15 held between the yokes 12 and 13 and having a hollow space 15a, two coils (solenoids) 14, 16 connected in series with each other to be used as two solenoids and wound on the bobbins 15 and 15′ respectively in the opposite directions from each other, a plunger 17 formed of magnetic material and serving ~~serves~~ as an iron core of which the hollow space 15a is movable in the axial direction, and a conical spring 20 for urging the plunger 17 in the direction of projection.

The yokes 12, 13 are arced-shaped flat plate members placed in parallel with each other, each having a curvature radius of R0 and a width of H1, and holding the coil 16 through which the fixed iron core 19 is inserted and a coil 14 having a hollow space 15a via the bobbins 15, 15′ therebetween. In this state, the winding axes of the coils 14 and 16 are held in parallel with each other and orthogonal to the plane of the yokes 12, 13.

The plunger 17 has a band of projection that rises slightly in the radial direction at the end of the shaft portion 17a to be inserted into the hollow space 15a of the bobbin 15 as shown in an enlarged view in Fig. 8. The band of projection has a prescribed width and forms a spherical

exciting voltage of the electromagnetic unit 42 applied to the coils 45, 47 is in the off state, the plunger 49 is released, and the plunger abutment portion 7b of the shutter lever 7 is pressed by a urging force of the conical spring 52. Since the urging force of the conical spring 52 is larger than the urging force of the shutter spring 8, the shutter lever 7 rotates counterclockwise, and the shutter blades 4, 5 rotate to the closed position shown in Fig. 11.

When the control signals for driving the solenoid ~~is~~ are supplied from the CPU in association with the start of light exposure, an exciting voltage is applied to the coils 45, 47 of the electromagnetic unit 42, and power distribution is started. The plunger 49 is sucked to the sucked position. In accordance with sucking operation of the plunger 49, the shutter lever 41 rotates clockwise from the state shown in Fig. 11 by an urging force of the shutter spring 8. The rotation of the shutter lever rotates the shutter blades 4, 5 to the opened position via the shutter blade driving pin 41c, and then light exposure starts.

After the lapse of light exposure time, power distribution to the coils 45, 47 of the electromagnetic unit 42 is stopped by the control signals for releasing the solenoid supplied from the CPU, and the plunger 49 is projected. The shutter lever 7 is pressed by the extremity 49c of the plunger 49 and rotates counterclockwise. The

opening and closing the shutter blades may be obtained.

On the other hand, attachment of the electromagnetic unit 42B to the shutter body 3 may be performed in the same manner as in the case of the electromagnetic unit 42. In this state, the plunger 49, the coil 45B, the coil 47B are arranged in a state in which the direction of the axis and their winding axes lie along the circumference of the optical axis O.

In this arrangement, the electromagnetic unit 42B is accommodated between the outer periphery of the taking lens 2B and the inner periphery of the lens frame 1B as shown in a cross sectional view in Fig. 18, and the outline of the taking lens 2B is shouldered in order to decrease the outer diameter D3 of the lens frame 1B. In other words, the electromagnetic unit 42B can be positioned closer to the optical axis O of the taking lens 2B to the extent corresponding to the decreased diameter of the coil 45B. Concurrently, the outer diameter of the taking lens 2B at the position where the coil 47B is located is decreased to the extent corresponding to the increased diameter of the coil 47B. As a ~~consequent~~ result, the outer diameter D3 of the lens frame 1B can be decreased to the extent corresponding to the distance that the electromagnetic unit 42B is moved toward the optical axis O in comparison with the outer diameter D2 of the lens frame 1 shown in Fig. 11.

WHAT IS CLAIMED IS:

1. An electromagnetic drive for controlling an ~~the~~ amount of light of a luminous flux, said electromagnetic drive comprising:

a solenoid in which the winding axis of the having a coil whose winding axis is disposed in parallel with the a direction of the luminous flux;

a movable plunger moved that is movable in parallel with the direction of the luminous flux by a magnetic force of the solenoid; and

a blade member driven by the movable plunger for controlling the amount of light of the luminous flux.

2. An electromagnetic drive for controlling the amount of light of a luminous flux according to Claim 1, wherein a plurality of solenoids are provided, and the plurality of solenoids are magnetically connected via a yoke member.

3. An electromagnetic drive for controlling the amount of light of a luminous flux according to Claim 1, wherein the movable plunger includes a band of projection provided around the movable plunger ~~thereof~~ in a ~~the~~ vicinity of an end portion ~~the extremity~~ of the movable plunger ~~located in the solenoid~~, and wherein the movable plunger is moved in the solenoid using the band of projection.

4. An electromagnetic drive for controlling the amount of light of a luminous flux according to Claim 1, further comprising:

a bearing portion for supporting the movable plunger at an end portion ~~near the extremity~~ thereof exposed out of the solenoid.

5. An electromagnetic drive for controlling the amount of light of a luminous flux according to Claim 2, wherein the plurality of solenoids have different central inner diameters from each other.

6. An electromagnetic drive for controlling the amount of light of a luminous flux according to Claim 2, wherein the plurality of solenoids have different outer diameters from each other.

7. An electromagnetic drive for controlling the amount of light of a luminous flux according to Claim 6, further ~~wherein~~ comprising ~~provided is~~ a bearing portion which supports the movable plunger at an end portion ~~near the extremity~~ thereof exposed out of the solenoid, and a band of projection ~~is~~ formed on a ~~the~~ peripheral surface in a vicinity of the end portion ~~near the extremity~~ of the movable plunger to be fitted into the bearing portion, wherein ~~and~~ the movable plunger is slidably movable ~~moved~~ in the bearing portion using the projection.

8. An electromagnetic drive for controlling an ~~the~~ amount of light of a luminous flux, said electromagnetic drive comprising:

a solenoid [in which the winding axis of the] having a coil whose winding axis is disposed in parallel with a ~~the~~ direction of the luminous flux;

a movable plunger ~~moved~~ that is movable in a direction parallel ~~with~~ to the direction of the luminous flux by a magnetic force of the solenoid;

a switching member for switching a ~~the~~ direction in which a locomotive faculty of the movable plunger acts from the direction ~~in~~ parallel to ~~with~~ the direction of the ~~a~~ luminous flux to a ~~into the~~ direction ~~in~~ perpendicular to the direction of the luminous flux; and

a blade member driven by the locomotive faculty obtained by the switching member.

9. An electromagnetic drive for controlling the amount of light of a luminous flux according to Claim 8, wherein the switching member pivots about the winding axis in parallel with the direction of the luminous flux.

10. An electromagnetic drive for controlling the amount of light of a luminous flux according to Claim 8, wherein a plurality of solenoids are provided, and the plurality of solenoids are magnetically connected by a yoke member.

11. An electromagnetic drive for controlling the amount of light of a luminous flux according to Claim 8, wherein the plurality of solenoids have different central inner diameters from each other.

12. An electromagnetic drive for controlling the amount of light of a luminous flux according to Claim 8, wherein the plurality of solenoids have different outer diameters from each other.

13. An electromagnetic drive for controlling the amount of light of a luminous flux according to Claim 8, wherein the movable plunger includes a band of projection provided around ~~thereof~~ the movable plunger in ~~the~~ a vicinity of ~~the extremity~~ an end portion of the movable plunger ~~located in the solen~~oid, and wherein the movable plunger is ~~moved~~ movable in the solenoid using the band of projection.

14. An electromagnetic drive for controlling the amount of light of a luminous flux according to Claim 10, further comprising:

a bearing portion for supporting the movable ~~iron core~~ plunger at ~~the extremity~~ an end portion thereof exposed out of the solenoid.

15. An electromagnetic drive for controlling the

amount of light of a luminous flux according to Claim 14, wherein the movable plunger includes a band of projection formed on ~~the~~ a peripheral surface ~~at the extremity thereof~~ in a vicinity of the end portion of the movable plunger to be fitted into the bearing portion, and wherein the movable plunger is ~~moved~~ movable in the bearing portion using the band of projection.

16. An electromagnetic drive for controlling ~~the~~ an amount of light of a luminous flux, said electromagnetic drive comprising:

a plurality of solenoids in which the winding axes of the having coils whose winding axes lie ~~lie on a plane~~ perpendicular to ~~the~~ a direction of the luminous flux;

a movable plunger ~~moved~~ that is movable along one of the winding axes by a magnetic force of the solenoid; and

a blade member driven by the movable plunger for controlling the amount of light of ~~a~~ the luminous flux.

17. An electromagnetic drive for controlling the amount of light of a luminous flux according to Claim 16, wherein the plurality of solenoids have different central inner diameters from each other.

18. An electromagnetic drive for controlling the amount of light of a luminous flux according to Claim 16, wherein the plurality of solenoids have different outer diameters from each other.

19. An electromagnetic drive for controlling the amount of light of a luminous flux according to Claim 16, wherein the plurality of solenoids are disposed along the direction of the luminous flux in such a manner that ~~a~~ the ~~plurality of~~ winding axes of the coils are respectively lying on planes ~~perpendicularly~~ perpendicular to the direction of the luminous flux, ~~are arranged~~ in parallel with each other.

20. An electromagnetic drive for controlling the amount of light of a luminous flux according to Claim 16, wherein the movable plunger includes a band of projection, provided around ~~thereof~~ the movable plunger in ~~the~~ a vicinity of ~~the extremity~~ an end portion of the movable plunger ~~located in the solenoid~~, and wherein the movable plunger is ~~moved~~ movable in the solenoid using the band of projection.

21. An electromagnetic drive for controlling the amount of light of a luminous flux according to Claim 19, further comprising:

a bearing portion for supporting the movable plunger at ~~the extremity~~ an end portion thereof exposed out of the solenoid.

22. An electromagnetic drive for controlling the amount of light of a luminous flux according to Claim 21,

wherein the movable plunger includes a band of projection formed on a ~~the~~ peripheral surface in a vicinity of the end portion of the movable plunger ~~near the extremity thereof~~ to be fitted into the bearing portion, and wherein the movable plunger is movable ~~moved~~ in the bearing portion using the band of projection.

23. An electromagnetic drive for controlling an ~~the~~ amount of light of a luminous flux comprising:

a plurality of solenoids having respective center axes corresponding to respective different lines ~~respectively~~;

a movable plunger that is movable ~~moved~~ along one of the center axes of the plurality of solenoids by a magnetic force of the plurality of solenoids; and

a yoke member for forming magnetic fluxes generated from the plurality of solenoids into a loop.

24. An electromagnetic drive for controlling the amount of light of a luminous flux according to Claim 23, wherein the plurality of solenoids have different central inner diameter from each other.

25. An electromagnetic drive for controlling the amount of light of a luminous flux according to Claim 23, wherein the plurality of solenoids have different outer diameters from each other.

26. An electromagnetic drive for controlling the amount of light of a luminous flux according to Claim 23, wherein the plurality of solenoids are disposed in parallel with each other.

27. An electromagnetic drive for controlling the amount of light of a luminous flux according to Claim 23, wherein the movable plunger includes a projection provided around ~~thereof~~ the movable plunger in ~~the~~ a vicinity of ~~the extremity~~ an end portion of the movable plunger ~~located in the solenoid~~, and wherein the movable plunger is moved in the solenoid using the projection.

28. An electromagnetic drive for controlling the amount of light of a luminous flux according to Claim 26, further comprising:

a bearing portion for supporting the movable plunger at ~~the extremity thereof~~ an end portion exposed out of the solenoid.

29. An electromagnetic drive for controlling the amount of light of a luminous flux according to Claim 28, wherein the movable plunger includes a band of projection formed on ~~the~~ a peripheral surface in a vicinity of the end portion of the movable plunger ~~at the extremity thereof~~ to be fitted into the bearing portion, and wherein the movable plunger is ~~moved~~ movable in the bearing portion using the band of projection

ABSTRACT ~~OF THE DISCLOSURE~~

An electromagnetic unit is provided for ~~In~~ a lens barrel in which ~~the~~ a light exposure controlling unit for controlling ~~the~~ an amount of light is integrated~~, an~~. The electromagnetic unit is employed as a drive source for driving ~~the~~ shutter blades, and ~~the~~ a direction of the movement of ~~the~~ a plunger in the electromagnetic unit is switched by ~~the~~ a shutter lever, and the shutter blades are opened and closed. ~~The~~ A coil and the plunger ~~constructing~~ of the electromagnetic unit are disposed in parallel with ~~the~~ an optical axis ~~O, and their arrangement contributes~~ to reduce the space required for the electromagnetic unit, whereby ~~enabling~~ downsizing of the light exposure controlling unit and the lens barrel is achieved